

Course 1

Optometrical Courses of Study

Anatomy of the
Orbit

by

Dr. M. B. Ketchum

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Optometrical Courses of Study

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Edited by WILLIAM S. TODD,
Vice President of A. O. A., and Chairman of
Department of Education

Anatomy of the Orbit

including "the eye and its appendages" and
"diseases of the eye the Optometrist should recognize"
by DR. M. B. KETCHUM

President, Los Angeles School of Ophthalmology and Optometry,
Los Angeles, Cal.

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Foreword by the Editor

The courses of study, of which this is the first, have been prepared by the Department of Education to help Optometrists now in practice. They are in no wise intended to take the place of the Optometry Schools. The early courses will be practical and later advanced studies will be prepared. The Department suggests that wherever possible study classes be held. Course No. 1 is very concise and a little later Dr. Ketchum intends to prepare a special advanced course that will be valuable. In addition to the book mentioned by Dr. Ketchum, I would suggest that the students have reference books, such as Lewis' Optical Dictionary and any good book on Anatomy. Professor F. A. Woll has a book on "Technique of Eye Dissections" that is simply wonderful, especially, if dissection is carried out. Dissection will teach more in one day than weeks of study. Dr. Earl Brown of Chicago has another good book on "Anatomy of the Eye," while a book I have just procured is "Anatomy and Physiology of the Eye," Needles Institute Series No. 1, which Dr. W. B. Needles has just published. This is arranged in the form of study outlines and would be of help to the student of this course. Any problem pertaining to the lessons, not clear to the student, will be answered if a stamped, addressed envelope accompanies the request.

W. S. TODD, *Editor*.



Anatomy of the Orbit

including
The Eye and its Appendages

In taking up the study of the eye it is well for the Optometry student to realize, that, while as a class the human eye is pretty much the same in all people, a great deal of comparative study has been necessary in order to arrive at a definite standard of anatomical and optical measurements and principles involved, so as to form a basis for consideration from all standpoints; hence the term "Schematic Eye" has been adopted to cover what may be considered as the perfect eye.

Every normal person has two eyes, either being a perfect mate for its fellow eye, and so situated in their respective positions as to be parallel and under such control of the eye muscles as to work and move together in perfect relationship when looking at objects at any and all distances.

They are located in the upper and front part of the skull, each in a bony cavity commonly called the orbit (eye socket).

The distance between the two eyes varies in different individuals owing to the fact that the measurements of any two skulls are not identical. However, in the average adult, the width usually found from the center of one pupil to the center of the pupil of the other eye, called pupillary distance (abbreviated P. D.) is about 60 mm. and ranges from 56 to 64 mm. ($2\frac{1}{4}$ to $2\frac{1}{2}$ inches).

The Orbit

The principal anatomical knowledge required for the Optometrist is a gross understanding of the orbit and a rather more intimate acquaintance with the eye, its functions, nerve and blood supply.

The orbit is the first to be considered because it serves as a protection of the eye which is imbedded within it in a body of fat, called the orbital fascia, which, however, offers no resistance to the movement of the eye in any direction.



Anatomy of the Orbit

The orbit is rather cone shaped with its base forward and the apex extending backward and inward at an angle of 40 degrees with the median plane.

It has four sides, four angles and nine openings, each opening a foramen, as it is called, plural foramina.

Bones of the Orbit

Each orbit consists of seven bones which are located as follows: —

Roof (above)	1. Frontal
Floor (below)	2. Superior Maxillary
	3. Palate
Nasal Side	4. Ethmoid
	5. Lachrymal
Temporal Side	6. Sphenoid
	7. Malar

As three of these bones serve to form a part of each orbit, viz.: — the Frontal, Ethmoid and Sphenoid, it requires only eleven separate bones to form both orbits. Not all of each bone is required to form the orbit but only what is called the “orbital portion” or part of these bones, otherwise they go to make up the skull.

The walls of the orbit as a whole form a strong, bony ring, at its base called the orbital margin. The four boundaries or walls make four angles, viz.: —

Superior external,
Superior internal,
Inferior external,
Inferior internal.

Anatomy of the Orbit

The following are the nine Foramina, viz.: —

- | | |
|------------------------------|---------------------------|
| 1. Supra-orbital, | 2. Infra-orbital, |
| 3. Anterior-ethmoidal, | 4. Posterior-ethmoidal, |
| 5. Malar, | 6. Nasal canal or groove, |
| 7. Spheno-maxillary fissure, | |
| 8. Optic Foramen, | 9. Sphenoidal Fissure. |

Of these nine openings only two concern the Optometrist to any extent and those are No. 8 and No. 9, because of the nerve and blood supply that enter the orbit through them.

The Optic Foramen

The Optic Foramen is a small round opening at the back part or apex of the orbit, through which the Optic Nerve and the Ophthalmic Artery enter the orbital cavity from the inside of the skull.

Sphenoidal Fissure

The Sphenoidal Fissure, a much larger opening on the temporal side of the orbit, serves as a passage way for the nerves, arteries, and veins, viz.: — The third, fourth and sixth cranial nerves; the frontal and lachrymal branches of the Ophthalmic or fifth division of the fifth nerve; filaments (branches) or the sympathetic nerve, the ophthalmic veins and also the lachrymal meningeal arteries.

The Blood Supply

The blood supply of the eye comes from the Ophthalmic Artery, (a branch of the Internal Carotid).

Dimensions of Orbit

The average dimensions of the orbit are: —

- Depth about 45 millimeters,
- Horizontal (at base) about 40 mm.,
- Vertical (at base) about 35 mm.



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Questions on Lesson One

1. What is meant by the term "Schematic Eye?"
2. Give measure of average pupillary distance. (P. D.)
3. How many degrees do orbits diverge from the median plane?
4. Give orbital measurements.
5. What is the difference between foramen and foramina?
6. How many foramina? Name the two principal ones.
7. What enters the orbital cavity through each one of the two?
8. Name and locate the bones of the orbit and also those that aid in the formation of both orbits.
9. What is meant by the orbital margin?
10. Name the four angles of the orbit.



Anatomy of the Orbit

The Eyeball

This lesson is merely a general outline of the eyeball and is intended to convey to the student sufficient knowledge to serve as a working basis for that which is most essential to him at this stage of his work, so that he can at once proceed to take up the study of Ophthalmic Optics and have a clear conception of what he is doing.

May on "Diseases of the Eye" gives detailed anatomy of the different parts of the eye as well as brief and splendid text and illustrations of diseases of the eye, so we have selected it as our text book to cover this part of the work; and the student is referred to the colored diagram of the eye shown next to the title page, as well as the beginning of the different chapters where the special anatomy of each part of the eye is given. (*See foreword by Editor*).

The Eyeball and Tunics

The Eyeball, sometimes called the Globe, because it is so nearly round, has Three Coats or Tunics, viz.:—

Tunics

<i>Name</i>	<i>Part of each Coat</i>
1. External,	Sclerotic and Cornea,
2. Middle,	Choroid, Ciliary body and Iris,
3. Internal,	Retina.

The Sclerotic

The Sclerotic, commonly called the "white of the eye" is a heavy fibrous opaque membrane and covers the posterior five-sixths of the ball.

The Cornea

The Cornea is the clear transparent section in front and covers the anterior one-sixth.

The Choroid

The Choroid is a thin layer of brown pigment, nerves and blood-vessels and lies close to the Sclerotic, lining it entirely.

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The Iris

The Iris is seen in the front part of the eye directly back of the cornea. It has an opening near its center, (usually a little to the nasal side), called the pupil.

The Ciliary Body

The Ciliary Body is back of and continuous with the Iris but cannot be seen from the front. It is composed of two parts — the CILIARY MUSCLES and the CILIARY PROCESSES. The Ciliary Muscles are called the Muscles of Accommodation because they aid in adjusting the focusing power of the eye. The entire second tunic is also called the VASCULAR COAT owing to its many blood-vessels, another name is the UVEAL TRACT, an old time term given to it owing to a section of the CILIARY BODY having somewhat the shape of a bunch of grapes, Uveal in the Latin meaning grapes.

The Retina

The RETINA is a very thin transparent membrane containing arteries and veins, and lines the choroid. It is the layer that receives the outside images and pictures them upon the brain through the OPTIC NERVE which enters the back part of the eye a little to the nasal side of its posterior pole or axis. The exact point upon the retina where all images are actually focused is located practically in the center of the retina and is called the MACULA LUTEA or yellow spot. Directly in the center of the yellow spot is the principal focal point of the eye and is called the fovea centralis or center of focus.

The Optic Axis

The OPTIC AXIS is an imaginary line, the central line of the globe direct through the center of the cornea and the lens to a point near the inner margin of the macula lutea.



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The Visual Axis

The VISUAL AXIS, a similar term, is not the OPTIC AXIS but is the line of vision, visual line, and is direct from the fovea centralis to the center of the object looked at, called the Point of FIXATION. The place where the optic nerve enters the eye is called the OPTIC DISC, it is also called the "BLIND SPOT."

The Crystalline Lens

The CRYSTALLINE LENS is a double convex, transparent, spherical body and is a little more convex behind than in front, it is located directly behind the Iris on a line with the pupil. Its purpose is to aid in focusing images upon the MACULA LUTEA. It is confined in a very thin transparent membrane, the lens capsule, and is held in position by delicate bands, the suspensory ligaments, which entirely surround it and are combined with the ciliary body and also surround the lens. This ligament, or ligaments, is an extension of the HYALOID MEMBRANE, a very thin transparent body lining the entire eyeball adjoining and separating it from the contents of the large chamber which is back of the lens.

There are three chambers in the eye: —

Anterior	Posterior	Vitreous
----------	-----------	----------

The ANTERIOR and POSTERIOR chambers are between the cornea and the lens, being separated by the Iris but still connected by the pupil. They are called Anterior and Posterior because one is in front and the other directly back of the Iris. These two chambers are filled with a thin, clear fluid called AQUEOUS HUMOR.

The large chamber back of the lens is the Vitreous Chamber which is filled with a thick and heavy transparent fluid called VITREOUS HUMOR; this fluid somewhat resembles the clear part of an egg, serves as a support to the tunics of the eye and keeps it in perfect shape.

Refractive Media

All the clear, transparent parts of the eye, namely the CORNEA, AQUEOUS HUMOR, LENS AND VITREOUS HUMOR are together, as a whole, called the REFRACTIVE MEDIA, and it is through these transparent, refracting media that all the images are focused upon the MACULA LUTEA.

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Anatomy of the Orbit

The average length of the eyeball from front to back is about 24 mm. Vertical and horizontal measurements are slightly less.

The Optic Nerve and Retina

The OPTIC NERVE is a long bundle of fibres coming from the brain through the Optic Foramen into the Orbital Cavity and enters the posterior part of the eye, through the sclerotic and choroid, it then expands like a cup in all directions forming the Retina, or it might be said that the Retina and the Optic Nerve together form the Optic Tract.

The Retina catches images, the impressions which pass through the Optic Nerve into the brain, meeting the Optic Nerve of the other eye, at the Optic Chiasm.

Quiz on Lesson Two

1. How many tunics? Name them.
2. Name the different parts of each tunic.
3. What color is the Choroid?
4. Is the pupil in the center of the Iris?
5. What constitutes the Ciliary Body?
6. What are the Ciliary Muscles for?
7. What and where is the Vascular Coat?
8. What part of the eye receives images from the outside?
9. Where does the Optic Nerve enter the eye?
10. How does the Optic Nerve get into the Orbit?
11. Name and locate the exact center of Focus.
12. Locate the Optic Axis and the Visual Axis.
13. Where is the blind spot?
14. Describe and locate the Crystalline Lens.
15. Where do we find the Hyaloid Membrane?
16. Name and locate the chambers of the Eye.
17. State the contents of each chamber.
18. What constitutes the refractive media?
19. Give size of eyeball.
20. Be sure to master the metric system of measurement.

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Anatomy of the Orbit

Muscles and Nerves of the Eye

Although the orbits diverge from one another, the eyes are perfectly parallel with each other and always move in perfect unison. They are enabled to do this because they are under perfect control, each of six muscles inside the orbit and external to the eyeball. Altogether there are seven muscles in the orbit, the seventh one raises the upper lid. These six muscles are called the extrinsic (meaning outside) muscles. The upper lid muscle is called the **LEVATOR PALPEBRARUM** (meaning, to lift the lid).

Extrinsic Muscles

The extrinsic muscles are as follows: —

- | | |
|---------------------|---------------------|
| 1. External Rectus | 2. Internal Rectus |
| 3. Superior Rectus | 4. Inferior Rectus |
| (Plural, Recti) | |
| 5. Superior Oblique | 6. Inferior Oblique |

All these seven muscles have their origin in the apex of the orbit around the Optic Foramen, excepting the inferior oblique which is located at the base of the orbit in front, just under the eye. The four recti muscles extend forward from the apex an equal distance apart and are attached to the sclerotic from 6 to 8 mm. from the margin of the cornea. The superior oblique muscle which also has its origin at the apex extends forward close to the nasal side of the orbit to the internal angle at its base and then through the small pulley called the Trochlea, from there it extends obliquely backward and over the upper and middle part of the eye where it becomes attached to the sclerotic just underneath the Superior Rectus. The Inferior Oblique from its origin under the nasal side of the front of the orbit, passes below the Inferior Rectus and is attached to the sclera on its temporal side about midway of the eye.

Intrinsic Muscles

The Muscles inside the eyeball are called **INTRINSIC MUSCLES** and are:

1. Ciliary Muscles or muscles of accommodation.
2. The Iris Muscles, circular and radiating; the circular muscles contract the pupil and the radiating muscles dilate the pupil.



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The Nerve Supply

The principal nerves of the eye that are of interest to the Optometrist are the **THIRD, FOURTH and SIXTH CRANIAL NERVES**. The third nerve, also called the **MOTOR OCULI**, supplies all the seven muscles of the orbit except two, the Superior Oblique is controlled by the fourth nerve and the External Rectus by the sixth nerve inside the eye, the third nerve contracts the ciliary muscles and also contracts the pupil in the Iris. The Sympathetic nerve dilates the pupil. Practically all the contents of the orbit, the eyeball, optic nerve and muscles are developed in a fibrous sheathe called the **CAPSULE OF TENON**.

Quiz on Nerves and Muscles

1. How many muscles in the orbit?
2. Name those attached to the orbit.
3. Study carefully the origin and insertion of each muscle.
4. Which nerve is called the Motor Oculi?
5. Name and locate the intrinsic muscles and give their nerve supply.
6. About what distance is the insertion of the Recti Muscles from the edge of the cornea?
7. What nerves supply the upper lid muscles and also the Superior Oblique Muscle?
8. Describe the Capsule of Tenon.
9. If the Motor Oculi was paralyzed, what effect would it have on the appearance of the eye?
10. What nerve regulates the muscles of accommodation?

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The Eyelids

The upper lid is the larger of the two. The anatomical term for lid is *Palpebra*. *Palpebra Superior* for upper lid and *Palpebra Inferior* for the lower. The space between the lids is called the *Palpebra Fissure* which averages about 30 mm. in length. The inner angle is called the *Inner Canthus*, and the outer angle is called the *Outer Canthus*. Near the *Inner Canthus* on each lid will be found a small opening, the *PUNCTA LACHRYMALIS* or point where the tears flow in the nose. Here, also, will be found a small elevation close to the nose, the *CARUNCLE*; between that and the cornea is a half-moon fold of tissue called the *PLICA-SEMILUNARIS*, which is said to be the vestige of the third eyelid and which is still found fully developed in birds and some of the lower animals.

The Eyelashes (Cilia)

The Eyelashes, (*Cilia*), are short thick hairs which form a double row at the margin of each lid and curve up in the upper lid and down in the lower lid. Each lid has the following arrangement of parts from the skin inwards:

- | | |
|-----------------------------------|---------------------|
| 1. Skin | 2. Areolar Tissue |
| 3. Orbicularis Palpebrarum Muscle | 4. Tarsal Plate |
| 5. Palpebral Ligament | 6. Meibomian Glands |
| 7. Conjunctiva | |

The upper lid also has in addition at the upper part, the front end or the insertion of the *levator palpebrarum*, which is the muscle that lifts the upper lid and serves to "open the eye." The *ORBICULARIS MUSCLE*, the *MEIBOMIAN GLANDS* and the *CONJUNCTIVA* are the three layers of the lid to be considered.

The Orbicularis Palpebrarum

The *Orbicularis Palpebrarum* is the muscle of the lids that forms a sort of band around them, which when it contracts serves to close the lids together. It is a flat muscle and lies close to the skin of the lid.

The Meibomian Glands

The *Meibomian Glands* are imbedded in the body of the lids close to the *Conjunctiva* on the inner side. There are about thirty-five in the upper lid and about twenty-five in the lower lid. They secrete an oily substance which serves to lubricate the eye as it exudes from the margin of the lids.



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The Conjunctiva

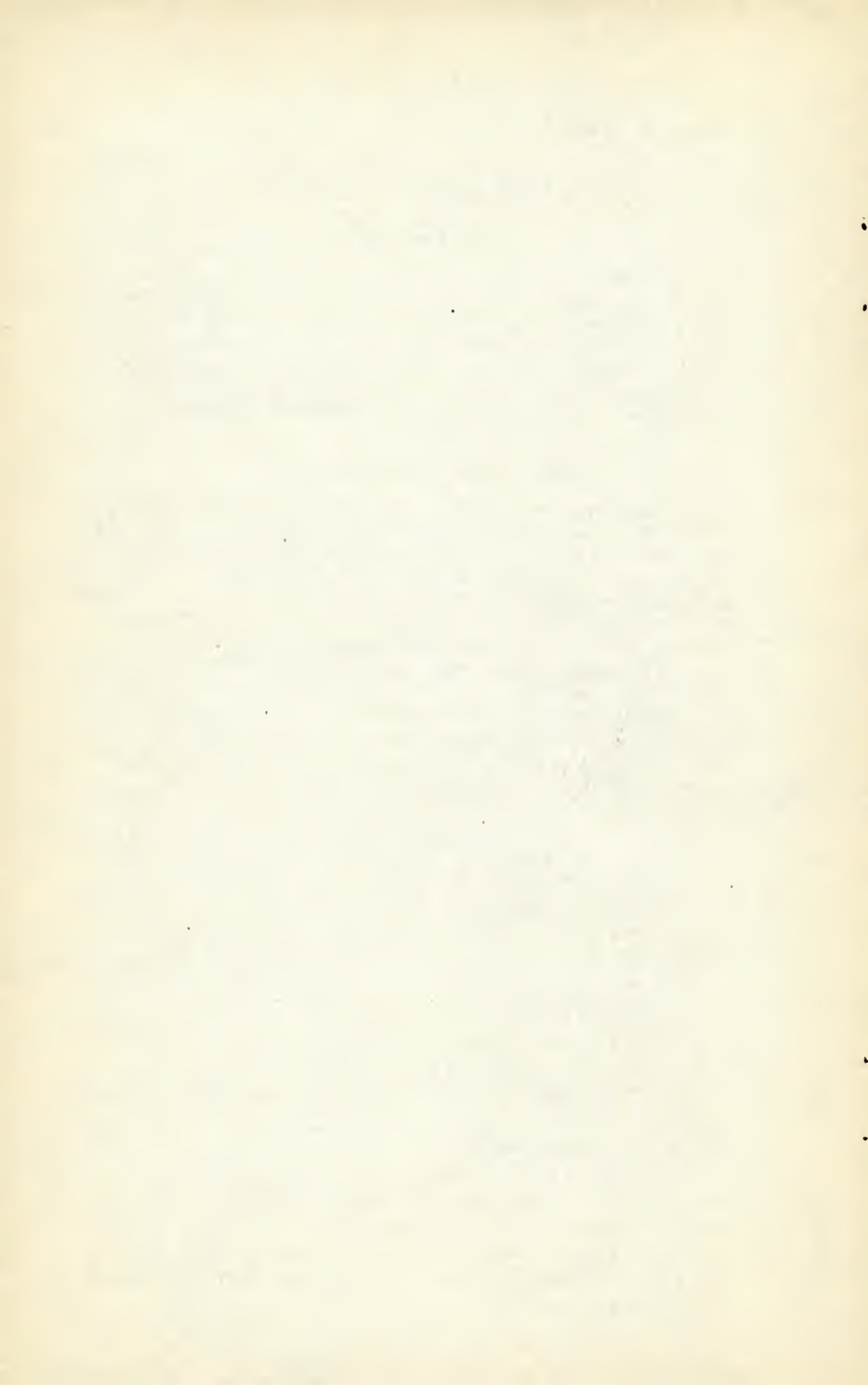
The Conjunctiva is a thin mucous membrane which begins at the edges of the lids, lines them and folds back upon the sclera (to which it is loosely attached) and covering the front of the eyeball to the margin of the cornea. It is really a network of blood vessels. The part lining the lid is called the Palpebral Conjunctiva, where it folds the FORNIX, and that which covers the sclera in front is the OCULAR CONJUNCTIVA.

The Lachrymal Apparatus

This refers to the secretion of the tears and of their disposal. The tears are secreted and formed in the lachrymal gland, which is a soft substance about the size of and shaped something like an almond. It is found at the base of the orbit at about the superior external angle, lodged in a depression of the bone. From the gland the tears (lachrymal fluid) pass through from 7 to 10 little tubules called the lachrymal ducts and flow over the eye, a part of the fluid evaporates and the balance flows into the nose. Upon the edge of each lid at the inner canthus will be seen a little opening—the puncta lachrymalis or canal—lachrymal canal—into a little sac near the nose—the lachrymal sac—and from these into what is called the nasal duct, a passage leading into the upper part of the nose.

Quiz on Lesson 4

1. What nerve and muscle lifts the upper lid?
2. Locate the palpebral fissure.
3. Where is the outer and inner canthus?
4. What is the name of the half-moon fold of tissue that is found at the inner canthus?
5. Which way do the eyelashes turn?
6. Name the layers of the lid.
7. Which are the most important layers?
8. How many Meibomian Glands in each lid and what are they for?
9. Locate the ocular conjunctiva.
10. Where is the fornix?
11. What is the lachrymal apparatus for?
12. Locate the lachrymal gland.
13. How do the tears get into the nose?
14. What are the points called that catch the tears at the inner canthus?



Diseases of the Eye the Optometrist should Recognize

External Diseases of the Eye

Conjunctivitis

Conjunctivitis — The Palpebral conjunctiva lines the lids. The Ocular conjunctiva covers the sclera in front.

Sub-acute or Simple Conjunctivitis will cause Photophobia (dread of light), no discharge or pus.

Catarrhal Conjunctivitis — Eye very red and inflamed, needs treatment only.

Trachoma

Trachoma or granulated lids — This is chronic inflammation of the conjunctiva — always photophobia — and nearly always haziness of the upper third of the cornea, called Pannus. You cannot refract satisfactorily.

Pterygium

Pterygium — is a fan-shaped growth of the conjunctiva extending from the inner canthus to the edge and sometimes upon the nasal side of the cornea. It interferes with satisfactory refraction and should be removed by operation.

Pinguecula

Pinguecula — is a small, fatty deposit in the sclera between the cornea and the inner canthus. It is not a disease, no harm comes from it, leave it alone.

Chalazion

Chalazion — Sub-acute tumor of one or more of the Meibomian Glands in either the upper or lower lid. No pain, usually grows larger in time and interferes with good visual acuity by pressing on the eyeball and distorting everything seen. Cannot refract very satisfactorily on that account. Advise operation.

Blepharitis

Blepharitis — Thickening of the edges of the lids by inflammatory process or eye strain. Small scales at the roots of the cilia and sometimes pimples, patients nearly always astigmatic. Refraction not always satisfactory until cured by treatment.

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Diseases of the Eye the Optometrist should Recognize

Hordeolum

Hordeolum — Common sty, very painful, often the result of eye strain.

Entropion

Entropion — is the result of injury or chronic disease of the lids causing the cilia to rub against the eyeball.

Ectropion

Ectropion — same cause as Entropion — edge of lid turns away from the eyeball. Usually the lower lid. This condition results in Epiphora.

Epiphora

Epiphora — is an overflow of tears upon the cheek because they cannot escape through the Puncta into the Lachrymal Canal.

Lachrymation

Lachrymation — is a term used to denote an excessive flow of tears from emotional causes.

Ptosis

Ptosis — Drooping of the upper lid. Usually congenital owing to incomplete development of the Levator Palpebrarum muscle. Operation does no good. If acquired, it is usually the result of acquired syphilis and means a partial paralysis of the third cranial nerve. Consequently all that the third nerve supplies is affected and we have cycloplegia-mydriasis with the cornea turned down and toward the outer canthus owing to the muscles being unable to hold it in the primary position and leaving it under the control of the external rectus and superior oblique.

Echymosis

Echymosis — "Black eye," result of injury.

Trichiasis

Trichiasis — "Wild Hairs" or eyelashes usually turning in and rubbing upon the eyeball causing much distress, operation necessary for relief.



Diseases of the Eye the Optometrist should Recognize

Nebula

Nebula — is an almost imperceptible haziness of all or a small part of the cornea.

Macula

Macula — is a small spot or opacity of the cornea, usually of the two anterior layers.

Leucoma

Leucoma — is a dense opacity of the cornea in part or in whole and usually the result of a serious injury or disease that affects the true corneal layer.

Pannus

Pannus — is a well defined haziness usually found in the upper third of the cornea, the result of Trachoma.

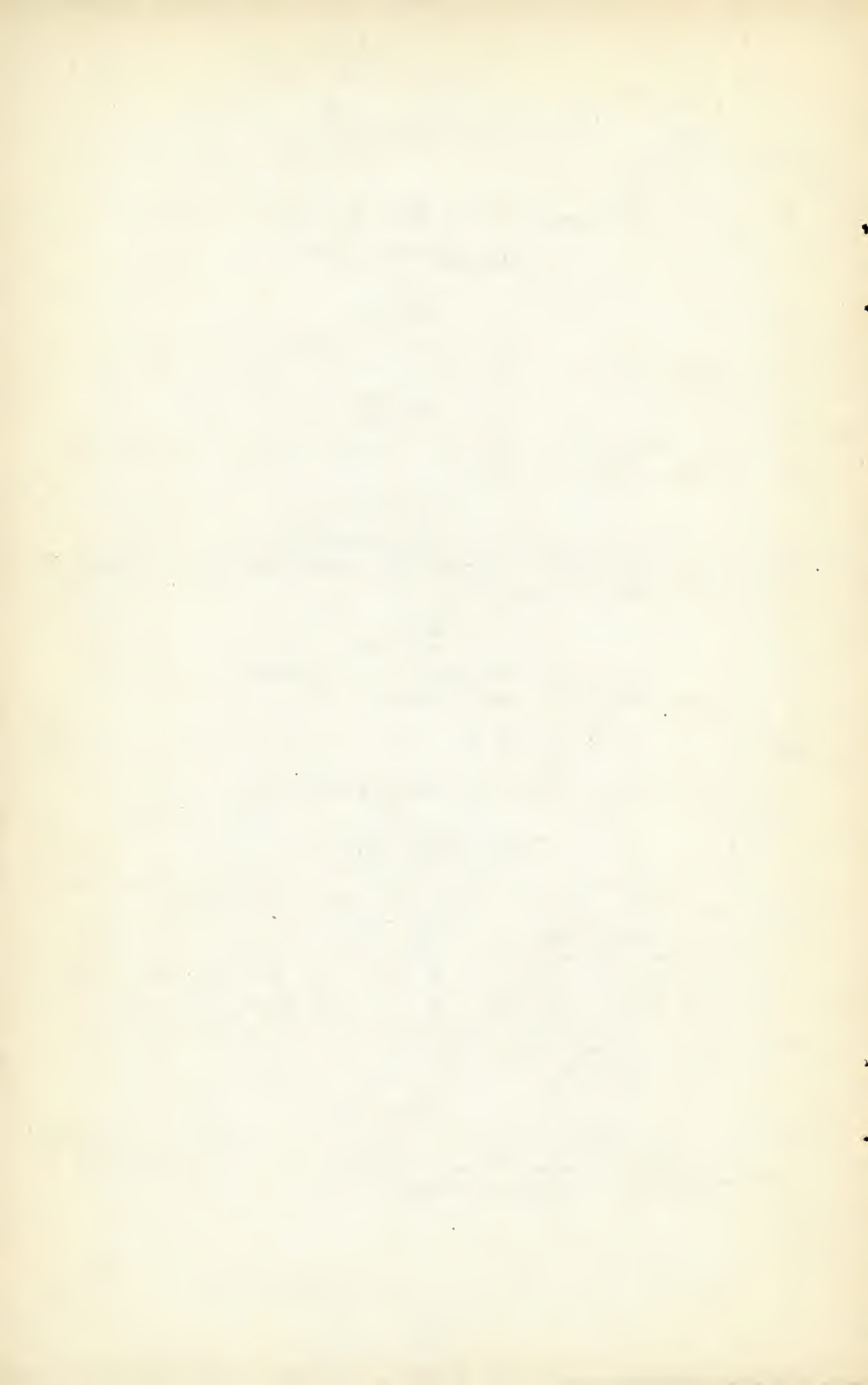
Internal Diseases of the Eye

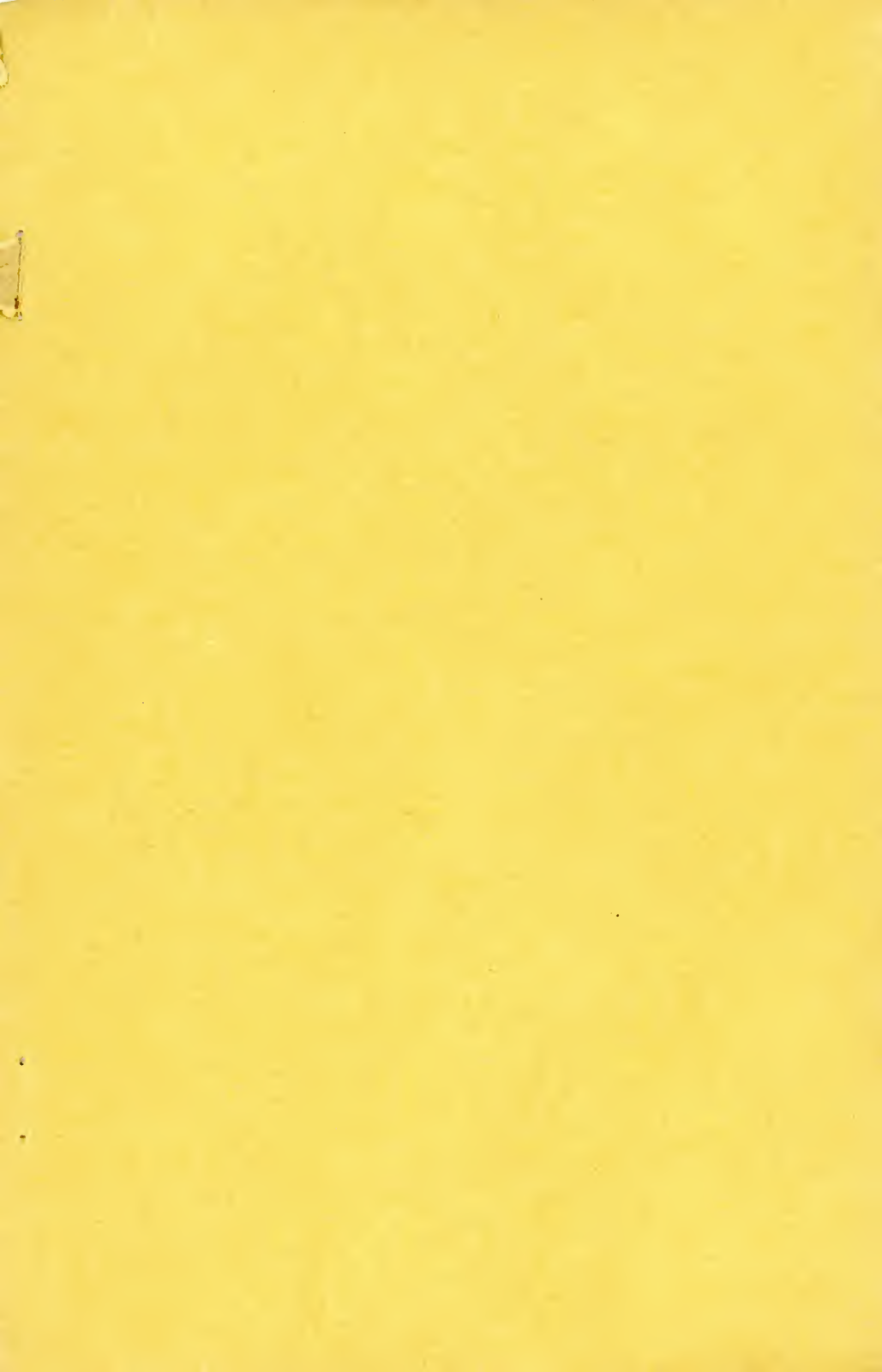
Acute Iritis

Acute Iritis — is very painful. Four principal symptoms are: pain, contracted pupil, iris looks dull, redness on the sclera around the cornea. Usually caused by syphilis or rheumatism. If not properly treated, it becomes attached to the lens capsule and will always remain that way, thus interfering with perfect vision, especially at the near point because the lens cannot change its focal power and the eye will always be more or less painful when attempting to see nearby objects. This condition is termed

Synechia

Posterior and Anterior Synechia — sometimes through accident or disease the front of the Iris becomes attached to the posterior side of the cornea.





Optometrical Courses of Study

Edited by William S. Todd
Vice President of A. O. A. and Chairman of
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